

# NuSTEAM

Nuclear Science in Texas  
to Enhance and Advance Minorities



Daniel Cherdack  
University of Houston



Snowmass Summer Workshop

University of Washington  
Seattle Washington

July 24<sup>th</sup>, 2022

# Outline

- Program goals
- Program overview
- Participating institutions
- Program at UH
- Program at BNL
- Home institution research projects
- The students
- Looking forward

# Program Goals

- Removing barriers for URM student participation in STEM
  - Competing priorities (e.g. the need to be paid)
  - Lack of mentorship
  - Lack of opportunities to “stand out”
- Provide training to students
  - Academic program on variety of NP/HEP topics
  - Technical skill useful for NP/HEP and industry
  - Hands-on experience with hardware and software
  - Presentation generation and delivery
- Networking and professional development
  - Opportunities to meet with and talk to URM students at multiple career levels
  - Travel to national laboratory to work with “physicists in the field”
  - A week of career development training
- Resume building
  - Program participation
  - Year-long paid research project
  - Opportunities to find letter writers
  - Talks and/or poster presentations
  - Potential for publications

# Program Overview

- The students
  - Rising seniors majoring in physics
  - From Minority Serving Institutions (MSIs)
  - Departments without graduate programs or standard NP/HEP portfolios
- The program
  - Six-week paid trainee program at UH
  - Two-week paid laboratory experience at BNL
  - Two-semester paid research experience at home institution
- The “Faculty”
  - A postdoc-level administrator
  - Academic faculty from UH delivering content in the mornings
  - Faculty and postdocs running afternoon activities that build on the morning lessons
  - External faculty teaching about career development and networking



Claudia Ratti  
Lead-PI



Israel Portillo  
Coordinator



# Lecturers



**Claudia Ratti (PI)**

Quantum Chromodynamics

Lattice QCD

Effective field theories

Theoretical heavy-ion physics



**Israel Portillo (Coordinator)**

Theoretical nuclear physics

Computational techniques

Hands-on exercise sessions



**Rene Bellwed**

Experimental heavy-ion physics

Detectors

Computational techniques

Professional opportunities in Nuclear Physics



**Daniel Cherdack**

Experimental neutrino physics

Neutrino fluxes and connections to nuclear physics

Applied math and statistics for neutrino physics



**Jamie Karthein (guest lecturer - MIT)**

Leadership

Self-awareness

Role of personality and personal history



**Lisa Koerner**

Experimental neutrino physics

Neutrino detectors

Neutrino experiments



**Lawrence Pinsky**

Low energy nuclear physics

Space science

Medical physics



**Anthony Timmins**

Experimental heavy-ion physics

Detectors

Computational techniques



**Angeliki Diane Rigos (guest lecturer - MIT)**

Leadership

Self-awareness

Role of personality and personal history



**Aymen Shamoan**

Aymen is a theoretical condensed matter graduate student. He will facilitate the summer program and help to make connections between different fields.



**Micheal Kahangirwe**

Micheal is a theoretical heavy-ion graduate student. He will facilitate the summer program and advise on academic career paths.

# Student Support

# Participating Institutions



- Hispanic Serving Institutions (HSIs)
  - UH
    - 50,000 students, 34% Hispanic
    - Top 5 US University for Hispanic Students
    - 2<sup>nd</sup> most diverse campus in the US
  - UTRGV
    - 25,000 students, 91% Hispanic
    - Largest in HSI TX, top 10 US
  - UTEP
    - 22,000 students, 84% Hispanic
    - 2<sup>nd</sup> largest HSI in TX, top 10 US
- Historically Black Colleges and Universities (HSBC)
  - PVAMU
  - Largest in TX with 10,000 students

# Program at UH

- Week 1: Theoretical Modeling and tools in relativistic heavy ion physics
  - Monday: Introduction to Mathematica
  - Tuesday: Introduction to Quantum Chromodynamics
  - Wednesday: Lattice QCD – solving QCD on your computer
  - Thursday: Statistical and phenomenological models
  - Friday: Results
- Week 2: Nuclear high energy physics at RHIC and the LHC
  - Monday: Big Bang Theory and forces in the universe
  - Tuesday: Phase transitions and the QGP
  - Wednesday: RHIC and LHC – accelerator and detector technology
  - Thursday: Results from RHIC
  - Friday: Results from LHC

# Program at UH

- Week 3: Experimental and Computational Techniques in relativistic heavy ion physics
  - Monday: Introduction to C/C++
  - Tuesday: Introduction to C/C++
  - Wednesday: ROOT: an analysis platform for heavy ions
  - Thursday: PYTHON and modern tools in nuclear and particle physics
  - Friday: the GRID: running TB of data around the world
- Week 4: Low energy nuclear physics, space science & medical physics
  - Monday: Technologies applied at lower energies in fund. nuclear research
  - Tuesday: The intersection between nuclear, space and medical science
  - Wednesday: Using nuclear state of the art detectors in space science
  - Thursday: Using nuclear state of the art detectors in medical applications
  - Friday: The future of high precision, robust detector development

# Program at UH

- **Week 5: Neutrino detection - Hardware and software techniques**
  - **Monday: The Physics of neutrinos**
  - **Tuesday: Neutrino Fluxes, Cross Sections, and Connections with Nuclear Physics**
  - **Wednesday: Neutrino detectors**
  - **Thursday: Neutrino experiments**
  - **Friday: Applied Math, Statistics, and Computing in Neutrino Physics**
- **Week 6: Prof. opportunities in Nuclear Physics, networking, presentation skills**
  - Monday: Leadership, self-awareness and the role of personality and personal history
  - Tuesday: Opportunities at universities, federal laboratories and at companies related to Nuclear/High Energy Physics
  - Wednesday: How to prepare professionally for a talk and a job interview
  - Thursday: Opportunities in seemingly unrelated fields
  - Friday: Student Presentations

# Program at BNL

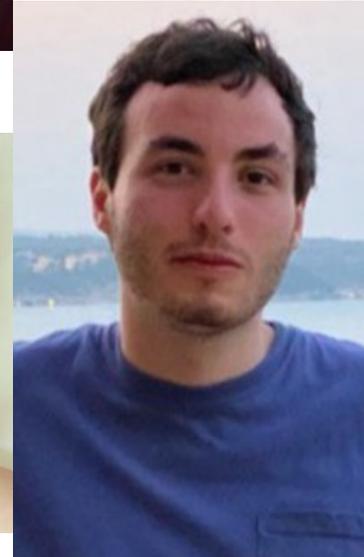
- Week 7: The STAR experiment at BNL
  - Monday: National holiday
  - Tuesday: Introduction of STAR detector and STAR Live Tour
  - Wednesday: STAR data acquisition system
  - Thursday: Forward tracking software
  - Friday: STAR forward upgrades -- forward silicon tracker and small-Strip Thin Gap Chamber
- Week 8: 7/11-7/15 – STAR and neutrino physics at BNL
  - Monday: STAR Muon Telescope Detector
  - Tuesday: STAR High-Level Trigger, hypertriton reconstruction
  - **Wednesday: Introduction to BNL neutrino program**
  - **Thursday: Introduction and tour of BNL liquid scintillator lab**
  - **Friday: Student presentations and discussions**

# Research Projects

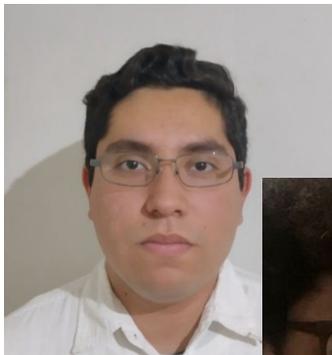
- Unique, year-long research topics at home institutions
- Projects chosen by and supervised by the local co-PIs
- Coordinate with UH faculty partners
- Regular Zoom meetings with
  - Participating students and PIs
  - Progress reports from all projects will be discussed
  - Optimize the student's presentation skills
  - Enhance their professional development
- Possible research topics are:
  - Mapping the phase diagram of matter in strong fields
  - Fluid dynamics in strongly interacting systems
  - Neutrino data analysis
  - Machine learning for particle analysis
  - Radiation measurements in space and atmosphere
  - Resting and operating a TPC
  - Phenomenological modeling of heavy-ion data

S U M M E R	UH Summer Training	
	<ul style="list-style-type: none"> <li>• Physics of RHIC &amp; LHC</li> <li>• Experimental Techniques</li> <li>• Theoretical modeling</li> </ul>	<ul style="list-style-type: none"> <li>• Low-energy applications</li> <li>• Hands-on computing</li> <li>• Professional skill training</li> </ul>
	BNL Traineeship	
F A L L + S P R I N G	Research projects at home institutions	
	UH Mentors	Matter in strong fields (1) Phenomenological modeling of heavy-ion data (1+1) UTRGV
		Machine learning (1) Detector testing and operation (1) UTEP
		Radiation Measurements (2) PVAMU
		Fluid Dynamics (1) Neutrino Physics (1) UH

# Participating Students - 2021



# Participating Students - 2022



# Lessons Learned and Looking Forward

- Lessons learned

- Meet the students at their level
  - Need to be realistic about “pre-reqs”
  - Each student has different skills/knowledge
- Activities will take longer than you think (less is more)
- Take time to listen to the students and be flexible
- Long days = fatigued students
- Travel can be daunting for undergraduate students

- Looking forward

- First two years have been highly successful
- Renew NuSTEAM through RENEW-NP following success (8 students)
- Apply for increased HEP student participation through RENEW-HEP (4 students)
  - Partner with the TPC
  - Extend lab experience to SURF
  - More integration of HEP program at UH